Re-Os ISOTOPIC SYSTEMATICS OF A CAI FROM THE ALLENDE METEORITE. H. Becker[1], R. J. Walker[1], J. N. Grossman[2], L. Grossman[3], G. J. MacPherson[4], J. W. Morgan[1], S. B. Simon[3], 1-Department of Geology, University of Maryland, College Park MD 20742 (e-mail: hbecker@geol.umd.edu), 2-USGS, MS-923, Reston, VA 22094, 3-Department of Geophysical Sciences, University of Chicago, 5734 South Ellis Avenue, Chicago IL 60637, 4-Department of Mineral Sciences, National Museum of Natural History, Smithsonian Institution, Washington DC 20560.

Introduction: Previously reported precise Re-Os isotopic data for chondrites sometimes show significant heterogeneities [1-3]. Normally, these appear as variable Re/Os with essentially constant $^{187}Os/^{188}Os$. Among possible explanations that have been proposed to explain these heterogeneities are analytical problems, recent alteration, chemical differentiation processes in the early solar system and primordial heterogeneities in the solar nebula. In order to evaluate these possibilies in carbonaceous chondrites, we have initiated a Re-Os isotopic study of CAIs. Our ultimate goal is to identify the components in which the heterogeneities occur. Using this information inferences on the causes of Re-Os isotopic heterogeneities can be made and initial assessments can also be made as to whether Os isotopic heterogeneities existed in the early solar nebula.

Samples and Analytical Techniques: The sample we have investigated is the large coarse-grained type-B2 inclusion F2 from Allende, which contains 40 vol. % melilite, 26 % Mg-Al spinel, 27 % fassaite and 7 % anorthite. A part of F2 was separated for the determination of major and trace element abundances by INAA. After a significant decay time, a portion of this sample was split into sub-samples which were counted again to estimate Ir/Sc. After a long decay time the splits were analyzed for Re-Os isotopes. Sub-samples 4 and 9 were split again and one half were analyzed unspiked for Re and Os isotopic compositions. The other half of sub-samples 4 and 9, and six other sub-samples (0.16-5.5 mg) were spiked with a mixed Re-Os spike [4]. Samples were dissolved in reverse aqua regia in sealed micro Carius tubes. Os was separated from Re by solvent extraction into CCl_4 and back extraction into HBr [5]. Re was separated from the matrix on small columns loaded with AG1-X8 resin using HCl and HNO_3. Samples were measured on the SECTOR 54 at UMCP, most of them on faraday cups in a static mode. The external precisions (mass spectrometric uncertainties only) are ±0.03 % or 0.2 % ($^{187}Os/^{188}Os$) and ±0.1 % or 0.3 % ($^{187}Re/^{188}Os$) for samples measured on faraday cups or the electron multiplier, respectively. Blank corrections are negligible for Os (<1pg), but the Re blank of 5±2.5 pg comprised a significant correction (0.2-5 %) in most samples.

Results: The two unspiked splits 4a and 9a were analyzed for their Re and Os isotopic composition to search for possible anomalies in the abundances of the stable isotopes of Re and Os. The $^{185}Re/^{187}Re$ of these samples agree with the value for our terrestrial Re standard within the external precision of 0.1 %. The $^{190}Os/^{188}Os$ and $^{189}Os/^{188}Os$ of the samples and our terrestrial Os standard agree at the 0.01% level, whereas the $^{186}Os/^{188}Os$. agree within 0.03 %. A comparison of unspiked and spiked splits of sub-samples 4 and 9 shows minimum differences in $^{187}Os/^{188}Os$ between 4a and 4b of 0.2 % and between 9a and 9b of 0.05 %, respectively (Table 1). On an isochron diagram (Fig. 1) six spiked CAI splits and two whole rock analyses of Allende [1] cluster relatively tightly on the band defined by isochrons of IIAB, IIIA and IVB iron meteorites [4, 6]. In contrast, the Re/Os of splits 5a and 7 are higher by 20 % and the high Re/Os are not supported by high $^{187}Os/^{188}Os$. The remaining six splits show small but significant variations in $^{187}Os/^{188}Os$ of as much as 0.5 %. These variations are not correlated with Re/Os, which show a total variation of less than 2 % (Table 1).

Discussion: We have no conclusive explanation for the high Re/Os of splits 5a and 7 other than possible contamination or accidentally high blanks. A somewhat higher blank contribution could explain the high Re/Os in split 7 with the small amount of Re (134 pg). However, for split 5a (489 pg Re) this would require a blank contribution of ca. 60 pg to raise $^{187}Re/^{188}Os$ from 0.4 to 0.44. This explanation is difficult to reconcile with the observed positive correlation of Re/Os with Ir/Sc in the CAI sub-samples (Table 1). On the other hand, we notice that no correlation exists between $^{187}Os/^{188}Os$ (which might be a more reliable proxy for Re/Os in the samples) and Ir/Sc. The narrow range in Re/Os for other sub-samples may suggest that our blank correction for these samples was appropriate. The error assigned to Re/Os in Table 1 incorporates the 50 % uncertainty assigned to the blank correction and for most samples this leads to effective uncertainties in Re/Os of ca. ±0.5 %. The observed range in $^{187}Os/^{188}Os$ of 0.5 % can be produced by radiogenic growth over 4.56 Ga if Re/Os of the samples differs by less than 1.5 %. Consequently, the lack of correlation between Re/Os and $^{187}Os/^{188}Os$ for the CAI splits likely reflects the uncertainty introduced by the blank correction. Sub-samples 9b and 1368, which have the smallest errors of all samples, have $^{187}Os/^{188}Os$ which are identical within error and Re/Os that differ by only 1 %. Split 9b plots slightly below the isochrons of IIA and IIIA irons [4], whereas split 1368 plots slightly above these isochrons. CAI data and whole rock data of Allende and CM chondrites define a correlation parallel to and overlapping with the iron meteorite isochrons (Fig. 1). This suggests that variations of Re/Os are the major cause of the observed variability of $^{187}Os/^{188}Os$ in carbonaceous chondrites. The extent of heterogeneities not related to the the Re/Os of the samples remains to be evaluated. To overcome the problems with Re blanks, larger portions of CAI samples will be analysed. We then hope to be able to better constrain variations of Re/Os in CAIs and to assess the variability in $^{187}Os/^{188}Os$.

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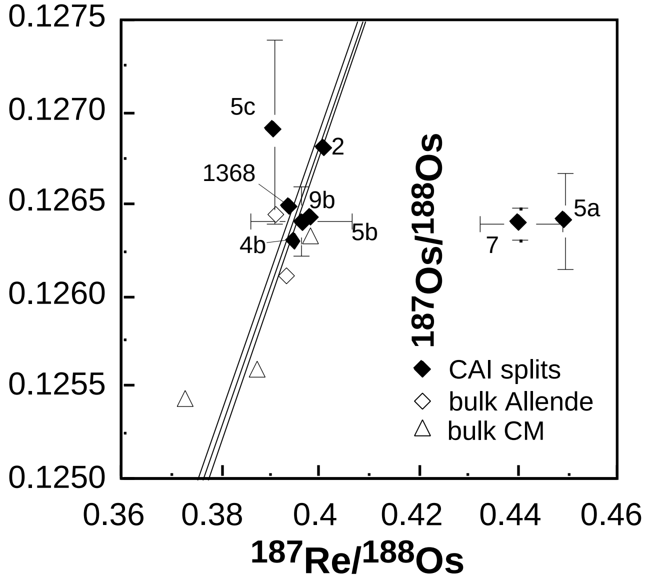

Fig. 1. Re-Os isochron diagram showing data for CAI F2, bulk rock data for Allende and CM chondrites [1] and isochrons for IIA, IIIA and IVB irons [4]. Numbers indicate different CAI splits. For samples without error bars, errors are similar or smaller than the size of the symbols.

Table 1. Re-Os data and Ir/Sc

Sample	sample wt. (mg)	Re (ng/g)	Os (ng/g)	$^{187}Re/^{188}Os$	$^{187}Os/^{188}Os$	Ir/Sc
F2-4a	0.95				0.12659±4	
F2-4b	0.92	595	7314	0.3947±18	0.12631±9	0.82
F2-2	0.94	529	6398	0.4008±20	0.12680±4	0.84
F2-9a	1.64				0.12654±6	
F2-9b	2.21	650	7908	0.3986±7	0.12642±4	0.80
F2-5a	0.34	1437	15516	0.4490±22	0.1264±3	6.82
F2-5b	0.16	607	7386	0.396±10	0.1264±2	2.53
F2-5c	0.75	419	5198	0.3911±29	0.1269±5*	0.33
F2-7	0.46	291	3208	0.4403±82	0.12639±9	1.19
F2-1368	5.33	522	6420	0.3940±4	0.12648±4	0.60

Errors on $^{187}Re/^{188}Os$ and $^{187}Os/^{188}Os$ correspond to the last digits and reflect 2σ external precisions and uncertainties from the Re blank contribution (5±2.5 pg). * Measured on the electron multiplier.